

WHAT IS CLAIMED IS:

1. A system, comprising:
a processor; and
5 a memory comprising program instructions, wherein the program instructions are executable by the processor to implement:
file system software configured to:
assign and migrate data in a multi-class file system comprising a
plurality of storage classes;
10 provide access to the data in the multi-class file system to one or more applications; and
migrate data that has not been modified for a given time interval
from a first storage class of the plurality of storage classes
to a second storage class of the plurality of storage classes,
15 wherein the data is not modifiable by the one or more applications while the data is on the second storage class;
and
a backup mechanism configured to back up the second storage class less
frequently than the first storage class.
20
2. The system as recited in claim 1,
wherein the file system software is further configured to migrate data that has not
been modified for a longer given time period from the second storage class
to a third storage class of the plurality of storage classes, wherein the data
25 is not modifiable by the one or more applications while the data is on the third storage class; and
wherein the backup mechanism is further configured to back up the third storage
class less frequently than the second storage class.
- 30 3. The system as recited in claim 1,

wherein the file system software is further configured to migrate data that has not been modified for a longer given time period from the second storage class to a third storage class of the plurality of storage classes, wherein the data is not modifiable by the one or more applications while the data is on the third storage class;

wherein the backup mechanism is further configured to back up the third storage class after said migrating the data that has not been modified for a longer given time period from the second storage class to the third storage class;

wherein the file system software is further configured to migrate the data that has not been modified for a given time interval from the first storage class to the second storage class after said migrating the data that has not been modified for a longer given time period from the second storage class to the third storage class; and

wherein the backup mechanism is further configured to back up the second storage class after said migrating the data that has not been modified for the given time period from the first storage class to the second storage class.

4. The system as recited in claim 1,
wherein, to back up the second storage class, the backup mechanism is further configured to generate an image-based full backup of the second storage class after said migration of the data to the second storage class; and
wherein, to back up the first storage class, the backup mechanism is further configured to generate image-based full backups of the first storage class and one or more incremental backups of the first storage class between the full backups of the first storage class.

5. The system as recited in claim 1, wherein the second storage class is write-locked, and wherein the file system software is further configured to:
disable the write lock of the second storage class prior to said migration; and

enable the write lock of the second storage class after said migration.

6. The system as recited in claim 1, wherein the file system software is further configured to compress the data migrated to the second storage class.

5

7. The system as recited in claim 1, wherein the backup mechanism is further configured to perform said back up of the second storage class without using a split mirror of the second storage class.

10 8. The system as recited in claim 1, wherein the file system software is further configured to:

receive a request to modify a portion of the data on the second storage class from one of the applications;

migrate the portion of the data from the second storage class to the first storage class in response to the request; and

15

modify the portion of the data on the first storage class according to said request.

9. The system as recited in claim 1, wherein the file system software is further configured to:

20 receive a request to delete a portion of the data from the second storage class from one of the applications; and

modify file system metadata to indicate that the portion of the data is deleted from the second storage class;

wherein one or more file blocks on the second storage class including the portion of the data are not modified by said deletion of the portion of the data.

25

10. The system as recited in claim 9, wherein the file system software is further configured to:

receive a request to restore the deleted portion of the data to the second storage class; and

30

modify the file system metadata to indicate that the portion of the data is restored

on the second storage class;
wherein the deleted portion of the data is not restored from a backup of the second storage class.

5 11. The system as recited in claim 1, wherein the plurality of storage classes are ordered in a hierarchy according to one or more characteristics from a highest storage class to a lowest storage class, wherein the first storage class is the highest storage class.

12. The system as recited in claim 11, wherein the one or more characteristics include
10 one or more of performance and cost.

13. The system as recited in claim 1, wherein the plurality of storage classes are ordered in a hierarchy according to performance characteristics from a highest storage class comprising one or more highest-performance storage devices to a lowest storage
15 class comprising one or more lowest-performance storage devices, wherein the first storage class is the highest storage class.

14. The system as recited in claim 1, wherein said migration of the data from the first storage class to the second storage class is transparent to the one or more applications.

20 15. The system as recited in claim 1, wherein the file system software is further configured to modify file system metadata for assigned and migrated data to indicate storage classes of the assigned and migrated data, wherein path information in the file system metadata exposed to the applications is not modified.

25 16. The system as recited in claim 1, wherein the data includes files or portions of files.

17. The system as recited in claim 1, wherein the data comprises one or more of
30 application data and file system metadata.

18. A system, comprising:

a plurality of storage devices;

a host system configured to couple to the plurality of storage devices via a
5 network, wherein the host system comprises:

file system software configured to:

assign and migrate data in a multi-class file system comprising a
plurality of storage classes, wherein each storage class
comprises one or more of the plurality of storage devices;

10 provide access to the data in the multi-class file system to one or
more applications; and

migrate data that has not been modified for a given time interval
from a first storage class of the plurality of storage classes
to a second storage class of the plurality of storage classes,
15 wherein the data is not modifiable by the one or more
applications while the data is on the second storage class;
and

a backup mechanism configured to back up the second storage class less
frequently than the first storage class.

20 19. A system, comprising:

software means for assigning and migrating data in a multi-class file system
comprising a plurality of storage classes and for providing access to the
data in the multi-class file system to one or more applications;

25 software means for migrating data that has not been modified for a given time
interval from a first storage class of the plurality of storage classes to a
second storage class of the plurality of storage classes, wherein the data is
not modifiable by the one or more applications while the data is on the
second storage class;

30 means for performing backups of the storage classes in the multi-class file system,

wherein the second storage class is backed up less frequently than the first storage class.

20. A method, comprising:
- 5 file system software assigning and migrating data in a multi-class file system comprising a plurality of storage classes;
- the file system software providing access to the data in the multi-class file system to one or more applications;
- the file system software migrating data that has not been modified for a given time
- 10 interval from a first storage class of the plurality of storage classes to a second storage class of the plurality of storage classes, wherein the data is not modifiable by the one or more applications while the data is on the second storage class; and
- backing up the plurality of storage classes, wherein the second storage class is
- 15 backed up less frequently than the first storage class.
21. The method as recited in claim 20, further comprising:
- the file system software migrating data that has not been modified for a longer
- given time interval from the second storage class to a third storage class of
- 20 the plurality of storage classes, wherein the data is not modifiable by the one or more applications while the data is on the third storage class; and
- wherein the third storage class is backed up less frequently than the second storage class.
22. The method as recited in claim 20, further comprising:
- 25 the file system software migrating data that has not been modified for a longer given time period from the second storage class to a third storage class of the plurality of storage classes, wherein the data is not modifiable by the one or more applications while the data is on the third storage class;

backing up the third storage class after said migrating the data that has not been modified for a longer given time period from the second storage class to the third storage class;

the file system software migrating the data that has not been modified for a given time interval from the first storage class to the second storage class after said migrating the data that has not been modified for a longer given time period from the second storage class to the third storage class; and

backing up the second storage class after said migrating the data that has not been modified for the given time period from the first storage class to the second storage class.

23. The method as recited in claim 20, wherein said backing up the plurality of storage class comprises:

generating image-based full backups of the second storage class after said migration of the data to the second storage class; and

generating image-based full backups of the first storage class and one or more incremental backups of the first storage class between the full backups of the first storage class.

24. The method as recited in claim 20, wherein the second storage class is write-locked, and wherein the method further comprises:

disabling the write lock of the second storage class prior to said migration; and enabling the write lock of the second storage class after said migration.

25. The method as recited in claim 20, further comprising compressing the data migrated to the second storage class.

26. The method as recited in claim 20, further comprising:

the file system software receiving a request to modify a portion of the data on the second storage class from one of the applications;

the file system software migrating the portion of the data from the second storage class to the first storage class in response to the request; and modifying the portion of the data on the first storage class according to said request.

5

27. The method as recited in claim 20, further comprising:
the file system software receiving a request to delete a portion of the data from the second storage class from one of the applications; and
the file system software modifying file system metadata to indicate that the
10 portion of the data is deleted from the second storage class;
wherein one or more file blocks on the second storage class including the portion of the data are not modified by said deletion of the portion of the data.

28. The method as recited in claim 27, further comprising:
15 the file system software receiving a request to restore the deleted portion of the data to the second storage class; and
the file system software modifying the file system metadata to indicate that the portion of the data is restored on the second storage class;
wherein the deleted portion of the data is not restored from a backup of the second
20 storage class.

29. The method as recited in claim 20, wherein the plurality of storage classes are ordered in a hierarchy according to one or more characteristics from a highest storage class to a lowest storage class, wherein the first storage class is the highest storage class.

25

30. The method as recited in claim 20, wherein the plurality of storage classes are ordered in a hierarchy according to performance characteristics from a highest storage class comprising one or more highest-performance storage devices to a lowest storage class comprising one or more lowest-performance storage devices, wherein the first
30 storage class is the highest storage class.

31. The method as recited in claim 20, wherein said migration of the data from the first storage class to the second storage class is transparent to the one or more applications.

5

32. The method as recited in claim 20, wherein the data includes files or portions of files.

33. The method as recited in claim 20, wherein the data comprises one or more of application data and file system metadata.

10

34. A computer-accessible medium comprising program instructions, wherein the program instructions are configured to implement:

assigning and migrating data in a multi-class file system comprising a plurality of storage classes;

15

providing access to the data in the multi-class file system to one or more applications;

migrating data that has not been modified for a given time interval from a first storage class of the plurality of storage classes to a second storage class of the plurality of storage classes, wherein the data is not modifiable by the one or more applications while the data is on the second storage class; and backing up the plurality of storage classes, wherein the second storage class is backed up less frequently than the first storage class.

20

35. The computer-accessible medium as recited in claim 34, wherein the program instructions are further configured to implement:

migrating data that has not been modified for a longer given time interval from the second storage class to a third storage class of the plurality of storage classes, wherein the data is not modifiable by the one or more applications while the data is on the third storage class; and

30

wherein the third storage class is backed up less frequently than the second storage class.

36. The computer-accessible medium as recited in claim 34, wherein the program
5 instructions are further configured to implement:

the file system software migrating data that has not been modified for a longer
given time period from the second storage class to a third storage class of
the plurality of storage classes, wherein the data is not modifiable by the
one or more applications while the data is on the third storage class;

10 backing up the third storage class after said migrating the data that has not been
modified for a longer given time period from the second storage class to
the third storage class;

the file system software migrating the data that has not been modified for a given
time interval from the first storage class to the second storage class after
15 said migrating the data that has not been modified for a longer given time
period from the second storage class to the third storage class; and

backing up the second storage class after said migrating the data that has not been
modified for the given time period from the first storage class to the
second storage class.

20

37. The computer-accessible medium as recited in claim 34, wherein, in said backing
up the plurality of storage classes, the program instructions are further configured to
implement:

generating image-based full backups of the second storage class after said
25 migration of the data to the second storage class; and

generating image-based full backups of the first storage class and one or more
incremental backups of the first storage class between the full backups of
the first storage class.

38. The computer-accessible medium as recited in claim 34, wherein the second storage class is write-locked, and wherein the program instructions are further configured to implement:

disabling the write lock of the second storage class prior to said migration; and
5 enabling the write lock of the second storage class after said migration.

39. The computer-accessible medium as recited in claim 34, wherein the program instructions are further configured to implement compressing the data migrated to the second storage class.

10 40. The computer-accessible medium as recited in claim 34, wherein the program instructions are further configured to implement:

receiving a request to modify a portion of the data on the second storage class
from one of the applications;
15 migrating the portion of the data from the second storage class to the first storage class in response to the request; and
modifying the portion of the data on the first storage class according to said request.

20 41. The computer-accessible medium as recited in claim 34, wherein the program instructions are further configured to implement:

receiving a request to delete a portion of the data from the second storage class
from one of the applications; and
modifying file system metadata to indicate that the portion of the data is deleted
25 from the second storage class;
wherein one or more file blocks on the second storage class including the portion of the data are not modified by said deletion of the portion of the data.

30 42. The computer-accessible medium as recited in claim 41, wherein the program instructions are further configured to implement:

receiving a request to restore the deleted portion of the data to the second storage

class; and
modifying the file system metadata to indicate that the portion of the data is
restored on the second storage class;
wherein the deleted portion of the data is not restored from a backup of the second
5 storage class.

43. The computer-accessible medium as recited in claim 34, wherein the plurality of
storage classes are ordered in a hierarchy according to one or more characteristics from a
highest storage class to a lowest storage class, wherein the first storage class is the highest
10 storage class.

44. The computer-accessible medium as recited in claim 34, wherein the plurality of
storage classes are ordered in a hierarchy according to performance characteristics from a
highest storage class comprising one or more highest-performance storage devices to a
15 lowest storage class comprising one or more lowest-performance storage devices,
wherein the first storage class is the highest storage class.

45. The computer-accessible medium as recited in claim 34, wherein said migration
of the data from the first storage class to the second storage class is transparent to the one
20 or more applications.

46. The computer-accessible medium as recited in claim 34, wherein the data includes
files or portions of files.

25 47. The computer-accessible medium as recited in claim 34, wherein the data
comprises one or more of application data and file system metadata.